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# *Echigoceras sasakii*, a new Middle Carboniferous nautilid from the Omi Limestone Group, Central Japan

SHUJI NIKO

*Department of Environmental Studies, Faculty of Integrated Arts and Sciences, Hiroshima University, Higashihiroshima, 739-8521, Japan (e-mail: niko@hiroshima-u.ac.jp)*

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**Abstract. A new genus and species of the trigonoceratid nautilid, *Echigoceras sasakii*, is described. Specimens of this cephalopod occur in the Middle Carboniferous (probable late Bashkirian) bioclastic rudstone/grainstone of the Omi Limestone Group, Central Japan. *Echigoceras* is most closely related to the Early Carboniferous genus *Stroboceras*, but differs in its strongly curved cyrtoconic shell and siphuncular position near the ventral margin. It is possible that *Echigoceras* is the descendant of *Stroboceras*.**

**Key words: *Echigoceras* gen. nov., Middle Carboniferous, Nautiloidea, Omi Limestone Group, Trigonoceratidae**

## Introduction

Following Niko (2001), the present report on a new trigonoceratid nautilid genus and species is the second installment in a series describing the Carboniferous cephalopod fauna of the Omi Limestone Group in Niigata Prefecture, Central Japan. All of the material documented herein is from the light gray, massive limestone belonging to bioclastic rudstone/grainstone of Middle Carboniferous (probable late Bashkirian) age at the southern corner of Higashiyama Quarry, the identical locality to that for the previously described orthoconic forms (Niko, 2001). The material is deposited in the University Museum of the University of Tokyo (UMUT).

## Systematic paleontology

Order Nautilida Agassiz, 1847
Superfamily Trigonoceratoidea Hyatt, 1884
Family Trigonoceratidae Hyatt, 1884
Genus *Echigoceras* gen. nov.

*Type species.*—*Echigoceras sasakii* sp. nov., by monotypy.

*Diagnosis.*—Trigonoceratid with strongly curved cyrtoconic shell whose surface is indented by longitudinal ridges and grooves; gross profiles of whorl are mostly subtrapezoidal, with inflated dorsal side; lobed peristome preserved as distinct growth lines characterized by V-shaped ventral sinus; siphuncular position near ventral margin; septal necks orthochoanitic, with very narrow septal foramina.

*Etymology.*—The generic name is derived from Echigo, which is a historic provincial name for the type locality.

***Echigoceras sasakii*** sp. nov.

Figures 1-4

*Stroboceras* sp., Oyagi, 2000, p. 108.

*Diagnosis.*—Same as for the genus.

*Description.* — Strongly curved, horseshoe-like cyrtocones consisting of less than one full circle, comprising approximately 0.91 of a full circle; shell size moderate for the family, maximum whorl diameter of holotype 45.0 mm; gross profiles of whorl are mostly subtrapezoidal with broadly inflated dorsal side and width/height ratio (form ratio) of approximately 0.94, then changing to laterally compressed suboval cross section near aperture, where whorl dimensions of 11.7 mm in width and 15.0+ mm in height give a form ratio of 0.78-; body chamber represented adorally by approximately one-third of whorl. Shell surface is indented by strongly prominent bilaterally symmetrical longitudinal ridges, as follows: 1 ventral (vr), 2 ventrolateral (v-lr1, v-lr2), 2 lateral (lr1, lr2), and 1 dorsolateral (d-lr); except for dorsal side of the shell, interspaces between longitudinal ridges are depressed and form longitudinal grooves; among these, there is a groove sandwiched between the ventrolateral and lateral longitudinal ridges (= between v-lr2 and lr1) that is deeply concave.

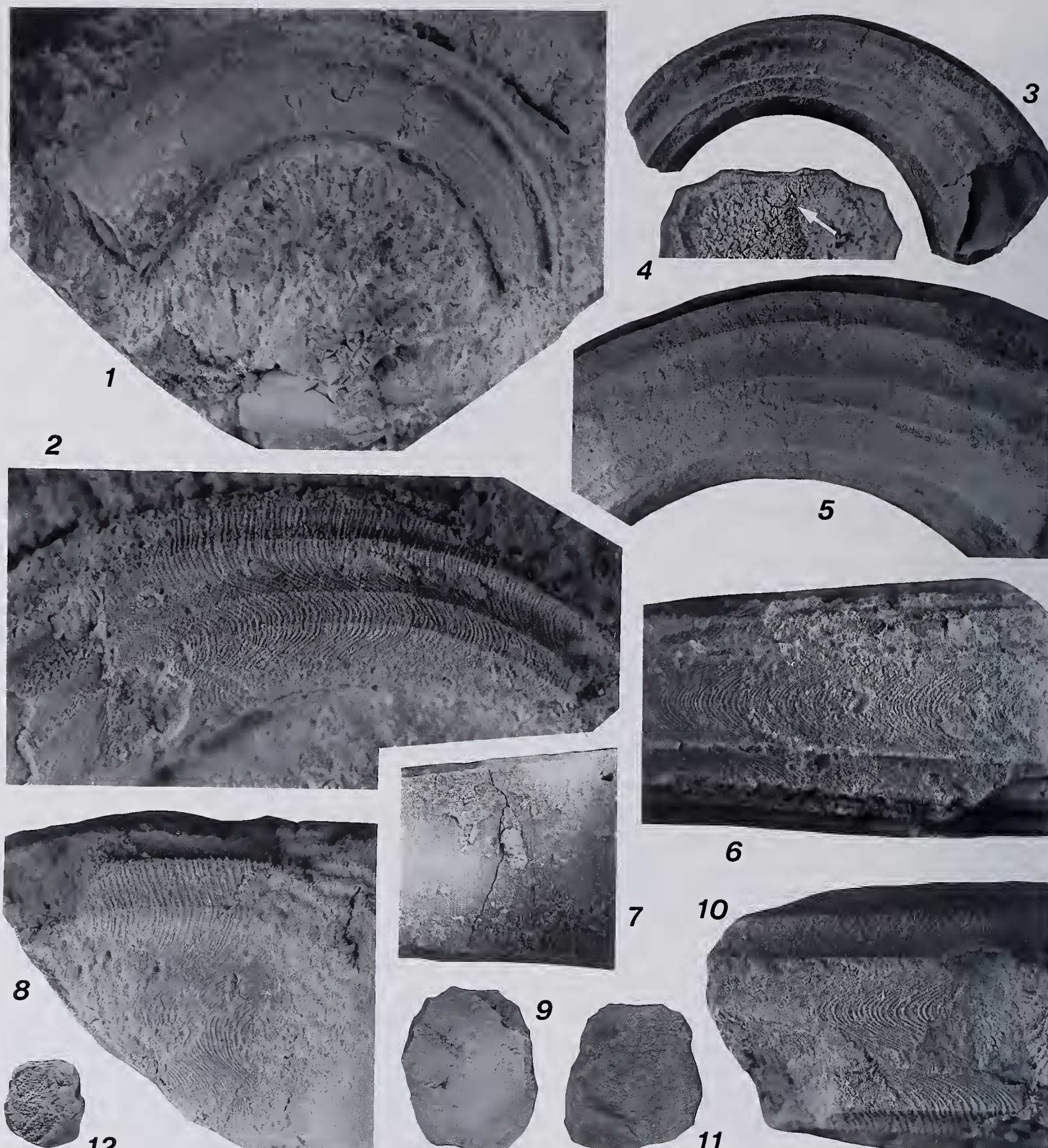


**Figure 1.** *Echigoceras sasakii* gen. et sp. nov. **1, 2**. Holotype, UMUT PM 27920; **1**, lateral view, aperture on left, apical shell embedded in matrix, and apertural shell partly removed, ×2; **2**, details of surface ornamentation, ×4. **3–7, 11, 12**. Paratype, UMUT PM 27919; **3**, lateral view, aperture on right, ×2; **4**, enlargement of ventral margin of Figure 1.12, showing siphuncular position (arrow), ×6; **5**, details of surface ornamentation, ×4; **6**, ventral view showing details of surface ornamentation, aperture on right, ×4; **7**, dorsal view showing details of surface ornamentation, aperture on right, ×4; **11**, cross-sectional view of adoral end, venter up, ×2; **12**, cross-sectional view of apical end, venter up, ×2. **8–10**. Paratype, UMUT PM 27921; **8**, lateral view, aperture on right, showing details of surface ornamentation and partial peristome, ×4; **9**, apertural view, venter up, dorsal shell partly lacking, ×2; **10**, ventral view, aperture on right, showing details of surface ornamentation, ×4.

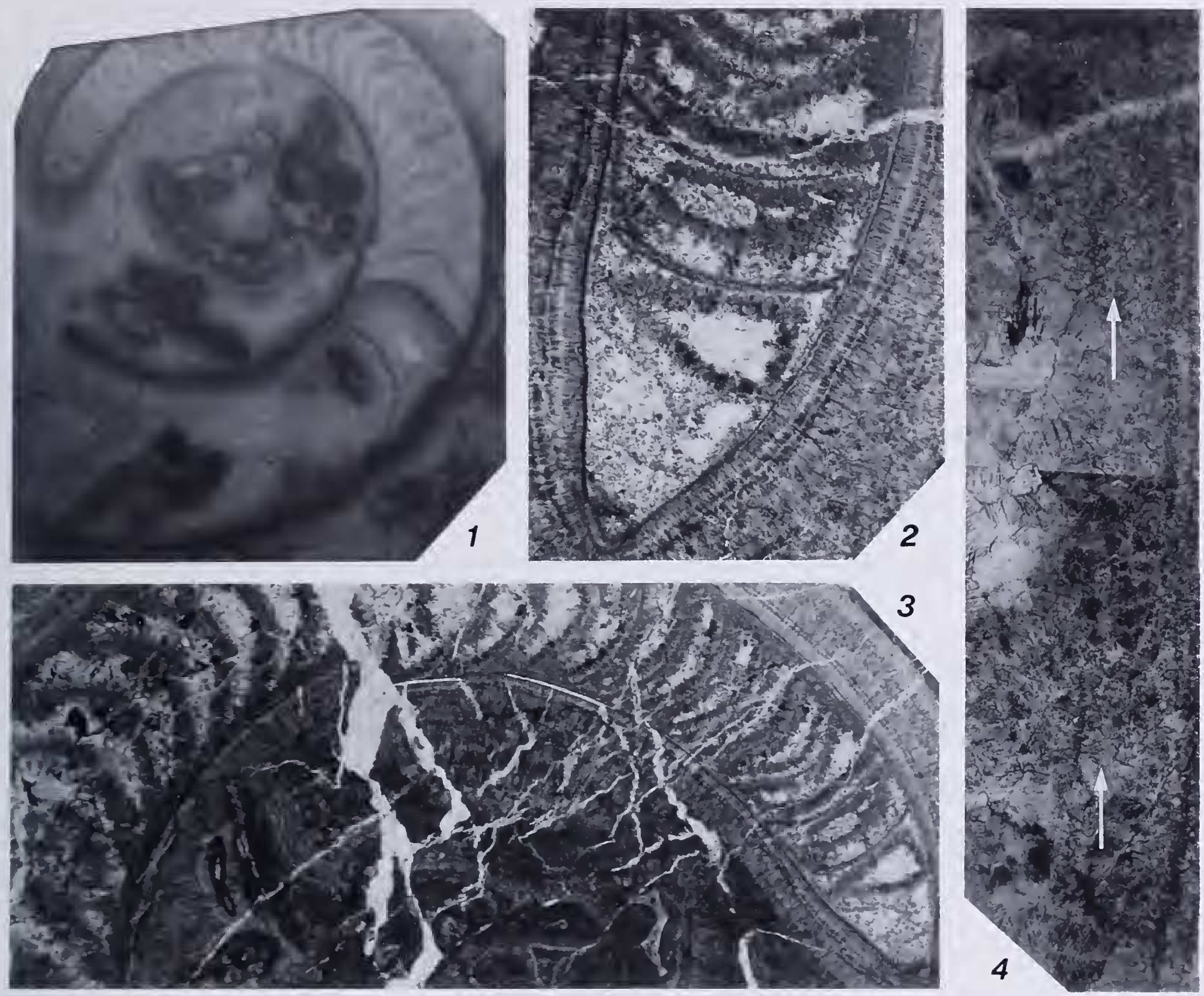


**Figure 2.** *Echigoceras sasakii* gen. et sp. nov. **1–4**. Holotype, UMUT PM 27920, longitudinal sections; **1**, polished section, ×2; **2**, thin section showing embryonic shell, not through siphuncle, ×10; **3**, thin section of apical shell, ×5; **4**, thin section with arrows indicate the septal foramina, ×25.

Peristome lobed, with deep, V-shaped ventral (hyponomic) sinus, broadly rounded ventrolateral saddle, moderately deep lateral (ocular) sinus and nearly transverse dorsal apertural rim; peristome preserved as distinct growth lines throughout shell; lateral and dorsolateral longitudinal ridges become subdued, and grooves between these ridges disappear near aperture. Judging from longitudinal section, embryonic shell probably is cone-shaped. Sutures not observable in all examined specimens, but serial longitudinal sections do not indicate distinguished obliquity and sutural elements. Cameral length moderate for family; there are 3 to 4 camerae in corresponding whorl height. Septa moderately concave for family, and form retrochoanitic siphuncle near ventral margin; ratio of minimum distance of central axis of septal foramen from whorl surface per corresponding whorl height (siphuncular position ratio) is approximately 0.08; septal necks orthochoanitic and relatively short with 0.71 mm in well-preserved dorsal septal neck at whorl height of approximately 9.5 mm, where diameters of septal foramina are very narrow for family at approximately 0.32 mm; connecting rings probably tube-like. Cameral and endosiphuncular deposits absent.

*Discussion*.—An Early Carboniferous genus *Stroboceras*

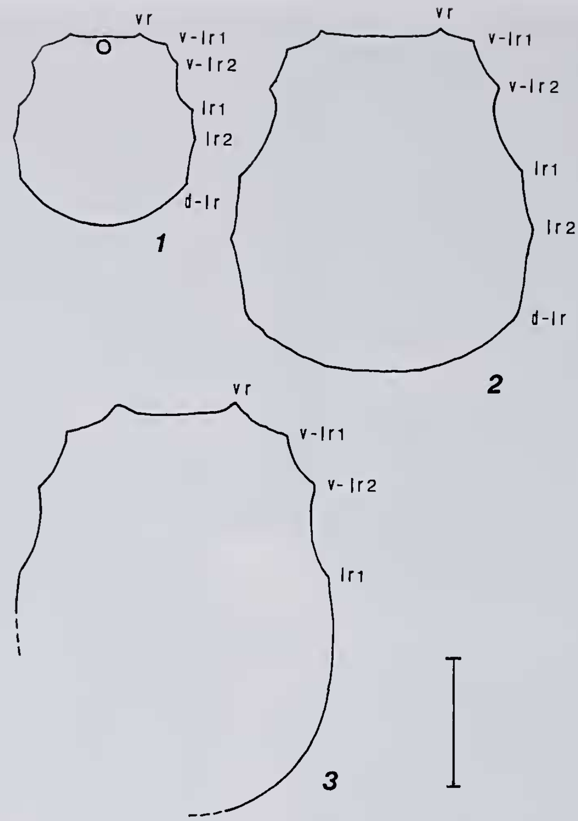


**Figure 3.** *Echigoceras sasakii* gen. et sp. nov., diagrams from cross sections of whorls, venter up. **1**, **2**. Paratype, UMUT PM 27919; **1**, phragmocone, note siphuncular position; **2**, body chamber. **3**. Paratype, UMUT PM 27921, body chamber near aperture. Abbreviations: vr = ventral ridge; v-lr1, v-lr2 = ventrolateral ridges; lr1, lr2 = lateral ridges; d-lr = dorsolateral ridge. Scale bar equals 5 mm.

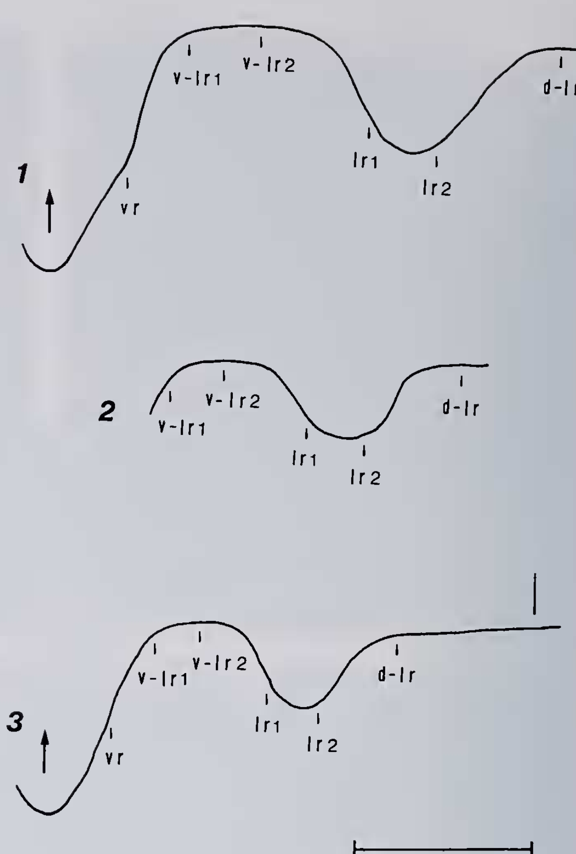


**Figure 4.** *Echigoceras sasakii* gen. et sp. nov., diagrams of growth lines to show peristome shapes in relation to the positions of the longitudinal ridges. **1**. Paratype, UMUT PM 27921. **2**. Holotype, UMUT PM 27920. **3**. Paratype, UMUT PM 27919. Positions of longitudinal ridges are indicated by symbols (see explanation of Figure 3). Scale bar equals 5 mm.

(Hyatt, 1884; type species, *Gyroceras harttii* [sic] Dawson, 1868) has the longitudinal ridges of, and a peristome outline similar to, *Echigoceras sasakii* gen. et sp. nov., and moreover all the outer whorls of *Stroboceras* are partly divergent each from the preceding one. Therefore, from fragmentary shells such as the present two paratypes (UMUT PM 27919, 27921), a distinction between *Echigoceras* and *Stroboceras* would be difficult to make based only on external morphology. In this case, the siphuncular position is the most diagnostic feature separating these genera; i.e., the position of the siphuncle near the ventral margin of the new genus contrasts with the siphuncular position of *Stroboceras*, which is subcentral to nearly midway between the center and the ventral margin. All trigonoceratids have cyrtoconic stages in their early ontogeny. In particular, the early juvenile shell of *Stroboceras hartii* illustrated by Bell (1929) most closely resembles that of *Echigoceras sasakii*, and the cyrtoconic parts of *Catastroboceras* (Turner, 1965; type species, *Nautilus quadratus* Fleming, 1828) and *Pseudocatastroboceras* (Turner, 1965; type species, *Coelonautilus trapezoidalis* Jackson, 1919) also possess longitudinal ridges, but they are less than 20 mm in shell diameter.

Among the known nautilids *Echigoceras* has the most similar shell morphology to *Stroboceras* as alluded to in the above comparisons. In addition, the range of *Stroboceras*, Visean to early Namurian of the Early Carboniferous (e.g., Gordon, 1964), was replaced by that of *Echigoceras*, for which a Middle Carboniferous (probable late Bashkirian) age is suggested. *Echigoceras* is the probable descendant of *Stroboceras*.

A figured specimen from the Omi Limestone Group cited as *Stroboceras* sp. by Oyagi (2000) is probably conspecific with *Echigoceras sasakii*. In addition, it should seem that *Stroboceras* sp. listed by Nishida and Kyuma (1986) from the Bashkirian to Moscovian of the

Akiyoshi Limestone Group, Southwest Japan, needs re-evaluation based on present knowledge. However, the specimens from these two localities are not presently available for re-examination.

*Etymology.*—The specific name honors the late Dr. Madoka Sasaki, in recognition of his contributions to the taxonomic study of living cephalopods.

*Material examined.*—The holotype, UMUT PM 27920, is a complete specimen. Unfortunately, attempts to separate the embryonic shell and apertural rim of the holotype from the well-indurated matrix were not successful. The following two paratypes of the fragmentary shells are assigned to the species: UMUT PM 27919, incomplete phragmocone with apical body chamber, 35.3 mm in length, and UMUT PM 27921, adoral body chamber including apertural rim, 15.9 mm in length.

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